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DECREMENT IN CHILDREN'S COGNITIVE PERFORMANCE AS A CONSEQUENCE OF INFORMATION OVERLOAD.

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TWO HYPOTHESES RELATED TO HYPOTHESIS INTERFERENCE IN CONCEPT PERFORMANCE OF YOUNG CHILDREN WERE TESTED/ (1) STUDENTS MAKE MORE CLASSIFICATIONS WHEN STIMULUS OBJECTS ARE PRESENTED SEQUENTIALLY THAN WHEN STIMULUS OBJECTS ARE PRESENTED SIMULTANEOUSLY, AND (2) REDUCING THE NUMBER OF STIMULUS OBJECTS INCREASES CLASSIFICATION SPEED. MATCHED ON THE BASIS OF STANFORD-BINET IQ SCORES AND SEX, 20 SECOND GRADE STUDENTS WERE SEPARATED INTO TWO GROUPS. BEFORE TESTING, A PENCIL SORTING TEST WAS DEMONSTRATED TO ESTABLISH A SET TOWARD CLASSIFICATION ON THE BASIS OF PHYSICAL ATTRIBUTES RATHER THAN AFFECTIVE OR FUNCTIONAL QUALITIES. THE SIX BLOCKS TO BE SORTED WERE PRESENTED SIMULTANEOUSLY FOR CHILDREN IN ONE GROUP (MPG) AND SERIALLY FOR CHILDREN IN THE OTHER GROUP (SPG). THE FIRST HYPOTHESIS WAS SUPPORTED BY THE DATA. SIGNIFICANTLY MORE SORTS WERE MADE BY THE SPG. HOWEVER, THE DATA INDICATE THAT REDUCTION OF STIMULUS OBJECTS DOES NOT LEAD TO FASTER DISCRIMINATIONS. NO SIGNIFICANT DIFFERENCES BETWEEN THE CLASSIFICATION SPEEDS OF THE TWO GROUPS WERE OBSERVED. THE STUDY SUGGESTS THAT SERIAL PRESENTATION OF EDUCATIONAL MATERIAL WOULD STIMULATE THE FORMATION OF MORE CONCEPTS THAN WOULD SIMULTANEOUS PRESENTATION. THIS DOCUMENT APPEARED AS STUDY 5 IN SCHOOL ANXIETY AND COGNITIVE FUNCTIONING/ EXPLORATORY STUDIES, REPORT 4, IRCOPPS MIDWEST RESEARCH CENTER FOR PUPIL PERSONNEL SERVICES, ANN ARBOR, MICHIGAN, PP. 141-164. (PS)

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SCHOOL ANXIETY AND COGNITIVE FUNCTIONING: EXPLORATORY STUDIES

University of Michigan

CG 000 929

IRCOPPS MIDWEST RESEARCH CENTER
FOR PUPIL PERSONNEL SERVICES

SCHOOL ANXIETY AND COGNITIVE FUNCTIONING: EXPLORATORY STUDIES

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PREFACE

This report is the fourth in a series of research monographs published by the IRCOPPS Midwest Research Center. A survey of Center activities plus a comprehensive synopsis of the Center's project reports may be found in the Center's 1967 Summary Status Report.

The present monograph reports the results of eight modular pilot studies conducted by various center staff. All research was supported by NIMH Grant #01428. Several of the studies have been presented, in abbreviated form, at various professional meetings and certain of the results have already appeared, or are due to appear, as short published articles.

Appreciation is expressed to the various staff associated with the production of these reports.

James A. Dunn
Director
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STUDY V

DECREMENT IN CHILDREN'S COGNITIVE PERFORMANCE AS A CONSEQUENCE OF INFORMATION OVERLOAD

ROGER O. SCOTT

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The acquisition of a concept can be inferred from classification behavior. When a subject classifies an object according to the presence or absence of a particular attribute, he has demonstrated the attainment of a concept. Concept performance can be viewed as a process of perceiving, hypothesizing, classifying, and checking. Some property of the object is perceived and a hypothesis is made as to whether that property is a critical attribute. If not, an attempt is made to perceive another property of the object. If the hypothesis is made that the property is a critical attribute, objects are classified on the basis of the presence or absence of the attribute. The reinforcement which follows this classification is the checking process.

Bruner, Goodnow, and Austin (1956) distinguish between concept formation and concept attainment. The former is the making of any hypotheses which attempt to bring order to a group of objects. Concept attainment is "... the process of finding predictive defining attributes that distinguish exemplars of the class one seeks to discriminate." (Bruner, et al., 1956, p. 22). According to these views, hypothesizing is equivalent to concept formation and the act of classifying is concept attainment.

Five conditions which affect concept attainment (and presumably concept formation) are discussed in the study previously cited. (Bruner, et al., 1956). These are:

(a) the definition of the task

(b) the consequences of a categorization

(c) the nature of the validation

(d) the imposed restrictions, and

(e) the nature of encountered instances.

The type of presented instance is the most widely tested of all conditions. Included in this category are such variables as the number and proportion of relevant attributes and the order in which the attributes are presented.

In the present study two specific modes of presentation were used while all other conditions were held constant. An attempt was made to compare presentations designed to maximize and minimize the effects of competing or interfering hypotheses.

Since 1920 when Clark Hull reported the first important concept attainment experiment, many researchers have investigated the differential effects of various presentation schemes. Hull (1920) found that S's allowed to procede at their own rate attained concepts more quickly when the presentation of stimulus objects progressed from simple to complex rather than from complex to simple. It can be argued that in the simple to complex presentation, S's formed fewer hypotheses at the beginning of the task. There was less interference because

of the lower number of hypotheses and thus the S's were able to attain the concepts more easily. Similar interpretations could be drawn from the results of other experiments. Reed (1950) found that concept attainment required more effort when the instances were presented simultaneously than when presented one at a time. These results agree with the theory of cognitive interference. There would be fewer interfering hypotheses in the case of the serial presentation. Peterson (1962) found interference effects between concepts when S's attempted to learn more than one concept in a serial presentation. The study showed, as have others, that an increase in the percentage of irrelevant attributes increases the difficulty of concept attainment.

There is little evidence of developmental differences in ability to deal with interfering hypotheses. Goldman and Levine (1963) found increasing precision and decreasing fragmentation in the labeling of object sorts with increasing S age. Although fragmented and imprecise responses can be thought of as resulting from an inability to deal with multiple hypotheses, it could also be interpreted as evidence of other types of theoretical or cognitive phenomena.

The manner in which interfering hypotheses can influence concept formation and concept attainment is most easily seen when the classification behavior of a subject is analyzed. When presented with a classification task, a subject may attempt to form a concept by either of two positive actions.

He may perceive an attribute, make a single hypothesis concerning the attribute, and attempt to reject all other perceptions and hypotheses. Another course of action is to attempt multiple perceptions and hypotheses. At the least complex level, this involves a subject making a perception leading to a hypothesis before acting upon a previous hypothesis. The interference resulting from simultaneous attempts to intake, store, and retrieve information which differs on the basis of the attribute involved is greater than the case of a perception followed by a single hypothesis. Interference from multiple hypotheses can be interpreted as short-term proactive and retroactive inhibition. Because retroactive inhibition becomes proportionately higher when the time interval is lessened, it would presumably account for nearly all of the interference in concept formation.

Young children, whose cognitive capacities are not fully developed, should, because of the interference, be more adversely affected by multiple hypotheses than would older children or adults. Young children should have less difficulty when classifying on the basis of single perceptions and hypotheses.

The present study tested two hypotheses related to hypothesis interference in concept performance of young children. The hypotheses were stated as follows:

(a) When stimulus objects are presented sequentially, with repetition of the classification concept, the S makes more classifications than when the entire set of stimulus objects is presented simultaneously.

(b) Reducing the number of stimulus objects increases classification speed.

METHOD

In order to test the hypotheses the present study compared two groups of S's on the basis of concept attainment and concept formation. The multiple presentation group (MPG) was asked to classify stimulus objects which were presented simultaneously. The serial presentation group (SPG) was asked to classify the same objects. For this group, only two objects were initially presented and after the S had formed a concept, additional objects were presented one at a time. In addition, the presentation for the SPG was structured so as to discourage the S from forming additional interfering hypotheses once he had made a choice of a critical attribute.

Subjects

Twenty second grade students were selected for the experiment. The S's were matched on the basis of Stanford-Binet IQ scores and sex. Eight boys and twelve girls were used. One S in each pair was randomly assigned to the SPG. The mean absolute IQ difference within pairs was 3.3 points. The range of differences was from one to five points. The S's were exceptionally intelligent. The distribution of IQ scores was relatively normal, ranged from 107 to 153, and had a median of 133. The mean absolute age difference within pairs was 4.4 months and the range for all S's was 11½ months.

Stimulus Materials

S's were asked to group the six small wooden blocks pictured in Figure 1. The blocks were originally developed by James Dunn in order to measure divergent cognitive processes. Other object sorting tests, e.g., the Hanfmann-Kasanin, Wisconsin Card Sort, Vigotsky, and Goldstein-Scheerer are convergent because of the severe limitations placed upon the type of sorts. There are usually a single or a few "correct" sorts and all others indicate the possibility of mental illness. (See Appendix B, page 162.)

Ten critical attributes of the blocks which would lead to a classification of two groups of three were selected. Only those classifications which matched the preselected attributes were scored. This eliminated most problems arising from attempts to determine if unusual sorts were logical or duplicative. The ten scored discriminations listed in terms of the critical attribute are as follows:

(a) color -- blue vs. yellow

(b) lightness -- light blue or yellow vs. dark blue or yellow

(c) surface finish -- glossy vs. flat

(d) roundness -- rounded sides vs. straight sides

(e) height -- tall vs. short

(f) volume -- large vs. small

(g) squareness -- length width vs. length = width

(h) angle at base -- columnar vs. pyramidal

(i) number printed on top -- 1 vs. 0, and

(j) size of shadow -- large vs. small.

Apparatus and Controls

A white cardboard screen (Figure 2) partially enclosed the 28" x 24½" sorting board. The purpose of the screen was to focus the S's attention on the board. Drawn on the white sorting board were two circles. Each was drawn with 1/8" thick black lines. The eight inch diameter circles were 18½" center to center and placed so that their centers were 11 inches from E's edge of the board. Midway between the circles was a small "x". Six evenly spaced "x"s formed a horizontal line on E's side of the circles. (See Appendix B, page 162.)

E wore a one-way vision pair of sunglasses throughout the experiment. This was done in order to prevent possible unconscious eye cues regarding the placement of the blocks. A 100 watt light bulb was placed 3 feet above the desk level and 3 feet to the right of the S. The light was left unshielded so that the experiment would be more easily replicated. The testing portion of the experiment was recorded on tape so that a more accurate analysis of the S's responses could be made. Another method of standardizing the procedure was to provide a script for E to follow. A list of instructions for various S responses is given in Appendix C.

Procedure

The order in which the S's were tested was determined by a random list of the matched pairs. Within each pair S's were

selected randomly. S's were called from their classwork by their teacher who introduced them to E. They were taken to a small office in an adjoining room and seated at a desk opposite E. In order to cancel some of the emotional variation between S's and to establish rapport, E talked with each S several minutes. S's were asked about the classwork which the experiment had interrupted and were told about the functions of the experimental apparatus.

Establishing a Set

Before testing the S's, a pencil sorting task was demonstrated. This was done in order to assist in the explanation of the test instructions and to establish a set toward classifying on the basis of physical attributes rather than affective or functional qualities. Most of the demonstration was given by means of a tape recorder so that the presentation differences between S's were minimized. The script of the demonstration can be found in Appendix A.

The stimulus objects used for the demonstration were four pencils. The pencils could be sorted into two equal groups in three different ways, depending upon whether a sharpened end, an eraser, or a clip was used as a critical attribute.

Test

After the set demonstration, the experiment departed from the double blind technique. E determined whether the S was in the MPG or the SPG and proceded with the appropriate presentation. For the SPG, two blocks were presented, one in the cen-

ter of each circle. The order of presentation was decided randomly with the exception that no pairs were repeated. After the S had made a discrimination, additional blocks were presented one at a time in random order. The S was asked to classify the blocks by choosing the circle in which each should be placed. As each new block was introduced, E repeated the discrimination originally given by the S.

All details of the MPG presentation were designed to correspond as closely as possible to the SPG procedure. The six blocks were presented simultaneously in random order. After the S had made a discrimination, he was asked to make a classification by pointing to the three blocks which should be placed in one circle and the three which belong in the other circle. A detailed description of the MPG and SPG procedures is given in Appendix B.

Dependent Variables

The number of classifications was determined by the number of sorts a S made which corresponded to the ten preselected classifications. In order to be scored, the sort also had to correspond to the discrimination verbalized by the S at the end of the task. Scoring only those sorts matching the S's discriminations eliminated the possibility of scoring a sort made without the formation of a concept.

Classification speed was determined by measuring the average time it took each S to make the discriminations which led to scored sorts of the stimulus objects. The time of the

discrimination leading to the last sort was not included in the data. It was hoped that the elimination of the last time would cancel some of the effects of high and low need achievement (n ach) and high and low test anxiety. S's with high n ach and low test anxiety have been shown to persist at a task much longer than S's with high test anxiety and low n ach. (Atkinson, 1964). Discrimination time was measured from the time E completed the question, "How are these two blocks different?" to the time the S began a reference to a critical attribute in a scored response. Before a sort was scored it had to correspond to the predetermined list of classifications. The S also had to complete the sort according to the discrimination verbalized at the beginning and the end of the task. The latter requirement insured that classification speeds which were measured actually led to classifications of the blocks.

RESULTS AND DISCUSSION

The number of classifications made by the SPG was significantly higher than the number for the MPG, $t(19) = 2.12$, $p < .05$. Using a signed test for matched pairs, the difference between untied pairs was significant far beyond the .001 level, $z = 4.96$. The mean of the scored sorts for the SPG was 5.4 and for the MPG, 3.3. An estimate of the strength of statistical association was determined from the t score. It was found that the presentation method accounted for an estimated 15% of the variance in the number of classifications.

These results agreed with the hypothesis and rationale which stated that the MPG makes fewer classifications as the result of a greater opportunity for interfering hypotheses.

The hypothesis which stated that the reduction of the number of stimulus objects increases classification speed was contradicted by the data. The average discrimination time for the SPG was 14.7 seconds and for the MPG, 13.2 seconds. The second hypothesis was not immediately rejected because of the possibility that the MPG, with fewer sorts, tended to make classifications which were easier and less time consuming than did the SPG. In order to equate the classification difficulty between groups, 21 of the 83 total sorts were dropped from the data. Each group was left with an equal number of each type of classification. An analysis of the remaining data showed the SPG's mean classification time per sort was 11.4 seconds and for the MPG, 10.3 seconds. These mean discrimination times indicate that a reduction of stimulus objects does not lead to faster discriminations (See Table 1).

Typical concept experiments have asked S's to find a predetermined concept. This experiment focused upon how many concepts a S could form and attain. It was found that the number of classifications increased when the presentation method was designed to minimize interference from competing hypotheses. The conclusion is in agreement with the previously cited experiments, (Hull, 1920; Reed, 1950; Peterson, 1962). These experiments yielded results from which the same con-

clusion could be made.

A second conclusion rejects the hypothesis that a presentation designed to minimize hypothesis interference leads to faster classification time. If hypothesis interference is responsible for lessening the number of classifications, it does not appear to slow discrimination time. The lack of discrimination time differences between groups casts doubt upon the theory of hypothesis interference. Both groups had comparable classification behavior with the exception of the SPGs' tendency to have more persistence in the task and therefore form more concepts. Apparently, some aspect of the presentation mode affected the motivation of the S's. One possibility is the SPG serial presentation of blocks gave those S's more success instances than did the MPG simultaneous presentation.

Concept learning experiments have important implications for education. Concepts are the essential part of students' learning and presentation modes can be especially well controlled in programmed learning. The results of this study are relevant to the problem of learning difficult concepts. In the case of concepts which are hard to learn it is often necessary to make several hypotheses before finding the correct one. The results are less useful in the case of easy concepts which are likely to be quickly formed and attained regardless of the presentation method. This study suggests that a serial presentation of educational material would

stimulate the formation of more concepts than would a simultaneous presentation of instances.

SUMMARY

The study concerned the number and speed of classifications which S's made using six small blocks. The classification was defined as concept attainment and the hypotheses leading to the sort were defined as concept formation. Two presentation methods were used; a multiple presentation of the blocks designed to maximize the formation of multiple hypotheses and a serial presentation (SP) designed to minimize multiple hypotheses. It was hypothesized that because of the interference effect of multiple hypotheses, the SP group would have more and faster classifications. Significantly more sorts were made by the SP S's but there were no significant differences between the classification speeds of the two groups.

TABLE 1

Number and Speed of Classifications

	Number			Average Speed in Seconds		
Group	$\bar{X}$	SD	Range	$\bar{X}$	SD	Range
SPG	5.4	2.41	1 - 9	14.7	7.8	2.2 - 25.0
MPG	3.3	1.75	1 - 7	13.2	9.3	4.0 - 19.5

The statistics for average speed do not include one SPG and two MPG cases whose one sort was dropped from the data.

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APPENDIX A

ESTABLISHING A SET DEMONSTRATION SCRIPT

E: Now I'm going to show you a game. We play this game with a tape recorder.

Tape Recorder (TR): that's me!

E: ... some blocks, and some pencils. Let's try the pencils first. Are you ready, tape recorder?

TR: Yes, I am.

E: (to S) Are you ready? O.K. Let's begin.

TR: Here are two pencils. This one is sharp and this one has a flat end. Here is another pencil. It belongs with this one because it's also sharp. Here is another pencil. It belongs with this one because it also has a flat end. These two are alike because they have sharp points. These two are alike because they have flat ends. Now let's do it a different way. Pick up the pencils, please, and hand them to Mr. Scott.

E: (to S) Thank you.

TR: This pencil has an eraser on it and this one doesn't. Here is another pencil. It belongs here because it has an eraser like this one. Here is another pencil. It belongs here because it, like this one, doesn't have an eraser. These two are alike because they both have erasers. These two are alike because they don't have erasers. Now we will do it one more way. Please pick up the pencils and hand them to Mr. Scott.

E: (to S) Thank you.

TR: Mr. Scott is holding a pencil in his hand. Point to where he should put it.

E: (if correct response) That's right. (if incorrect response) Well, we could, but I was thinking of putting it over here because this one has a clip like this one.

TR: Mr. Scott has another pencil in his hand. Point to where he should put it.

E: (if correct response) That's right. (if incorrect response) Well, I was thinking of putting it with this one because they both have a piece of tape around them.

TR: These two are alike because they both have clips. These two are alike because they have pieces of tape wrapped around them.

Note. -- At appropriate times E placed the appropriate pencils in the sorting board circles, held pencils on the "x" midway between the circles, and pointed to the pencils on the board.

APPENDIX B

TESTING PROCEDURE

Instructions Following Demonstration

Tape Recorder: Now, instead of pencils, we are going to use some blocks. Mr. Scott will show you six blocks. You should put three of them in each circle. The three in this circle should be alike in some way. The three in this circle should be alike in some way.

E: (to S) Ready? O.K. Let's start.

SPG Procedure

Two blocks were presented, one in the center of each circle. After the blocks were placed in the circles, E asked, "How are these blocks different?" If the S named more than one discrimination which could categorize the blocks, he was stopped and told, "Just tell me one way they are different." If the S repeated a discrimination which had led to a previous classification he was informed, "You have done it that way before. Tell me another way these two blocks are different." If there was no response for 20 seconds or if there was a question, the instruction "How are these two blocks different?" was repeated.

Additional blocks were presented one at a time. They were placed upon the "x" midway between the circles. E kept his hand touching the presented block. After the S stated the discrimination either in terms of a single attribute which varied between objects (The color's different), the

presence of two differing attributes (This one's blue and this one's yellow), or the presence and absence of an attribute (This one's blue and this one isn't), E presented an additional block. After the block was placed on the "x", E asked, "If these blocks are different because (here E inserted, using the S's own words, the discrimination which the S verbalized in his response, e.g. the color's different, some are blue and some are yellow, some are blue and some aren't) point to where I should put this block."

After the last block had been placed E asked, "Why did you put these in this circle and these in this circle?"

When the S was ready for the next sorting task, E said, "O.K. Let's put the blocks back and do it a different way." At this point the sequence was begun again.

MPG Procedure

Six blocks were presented simultaneously by placing each on one of the six "x"s in back of the circles. E asked, "How are these blocks different?" If S made a multiple discrimination, repeated a discrimination, or paused for 20 seconds, E made the same responses as in the case of the SPG procedure.

After a response E asked, "If these blocks are different because (here E inserted, using the S's own words, the discrimination which the S verbalized in his response) point to the three which should go in this circle." After a response E asked, "Point to the three which go in the other circle.

After the blocks had been placed, E questioned, "Why did you put these in this circle and these in this circle?"

When the S was ready for the next sorting task, E said, "O.K. Let's put the blocks back and do it a different way." At this point the sequence was begun again.

FIGURE 1

Number of Positive Sorts, By Age

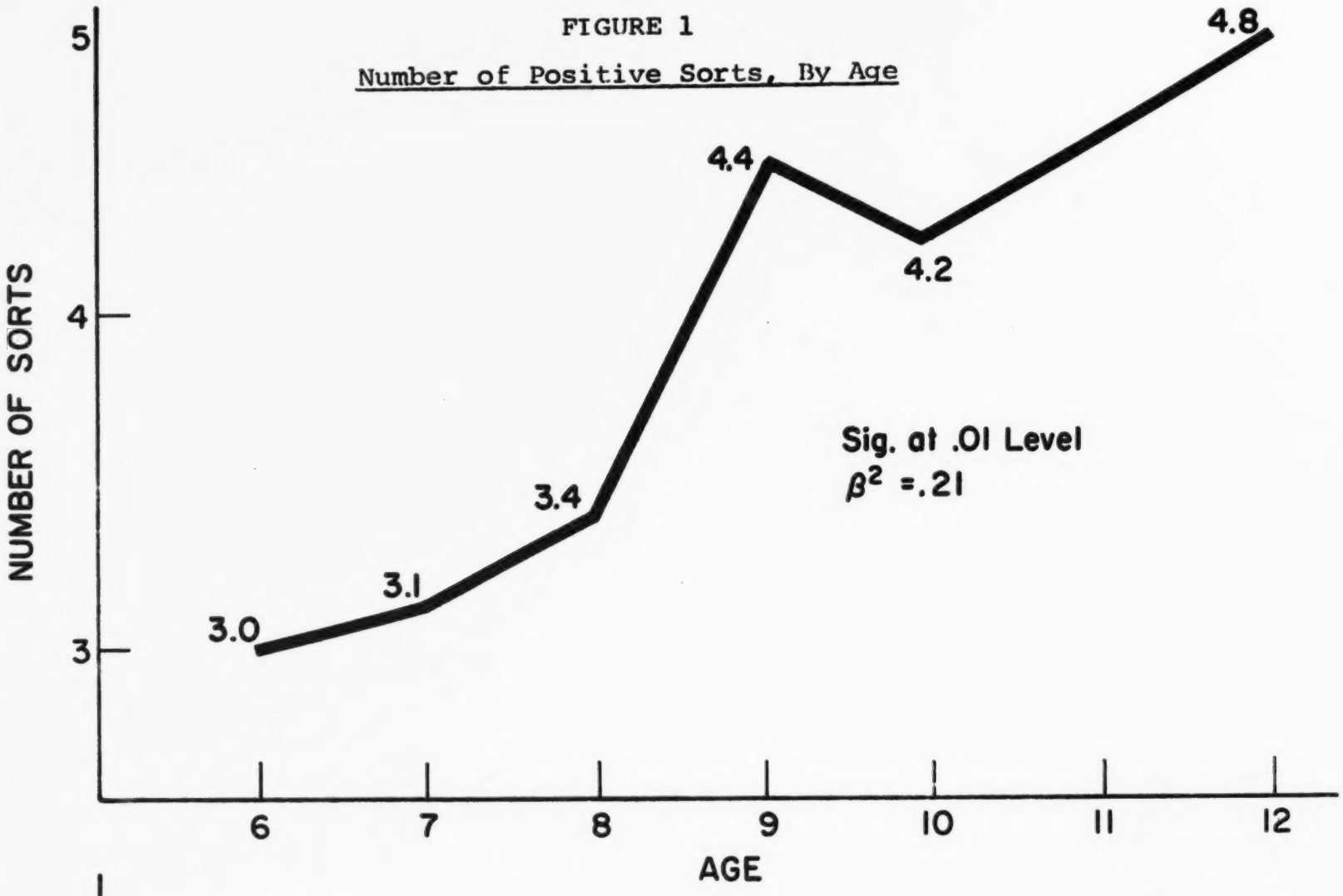


FIGURE 2

Total Verbalization Score, By Age

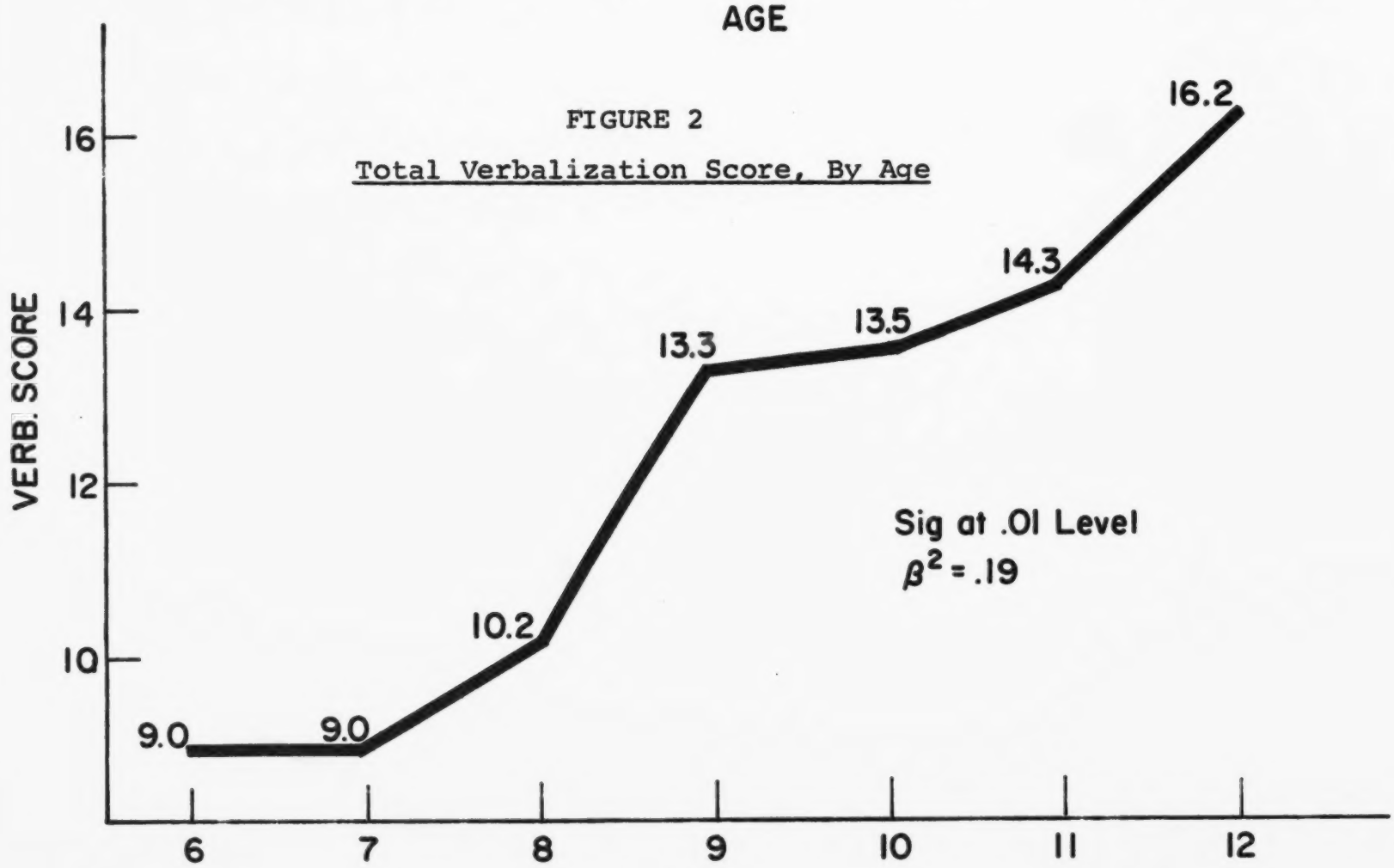


FIGURE 3

Number of Positive Sorts, By IQ Level

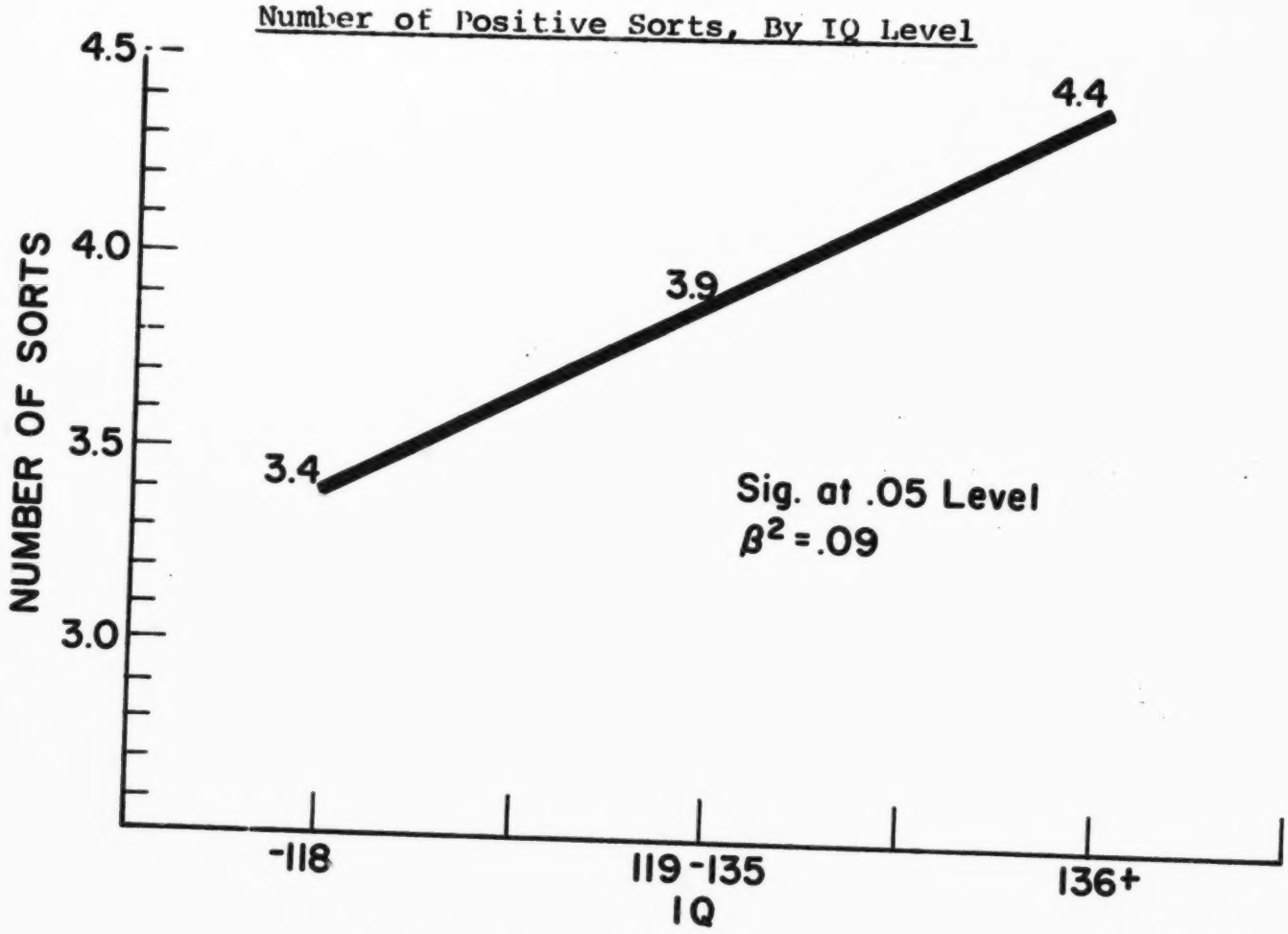


FIGURE 4

Total Verbalization Score, By IQ Level

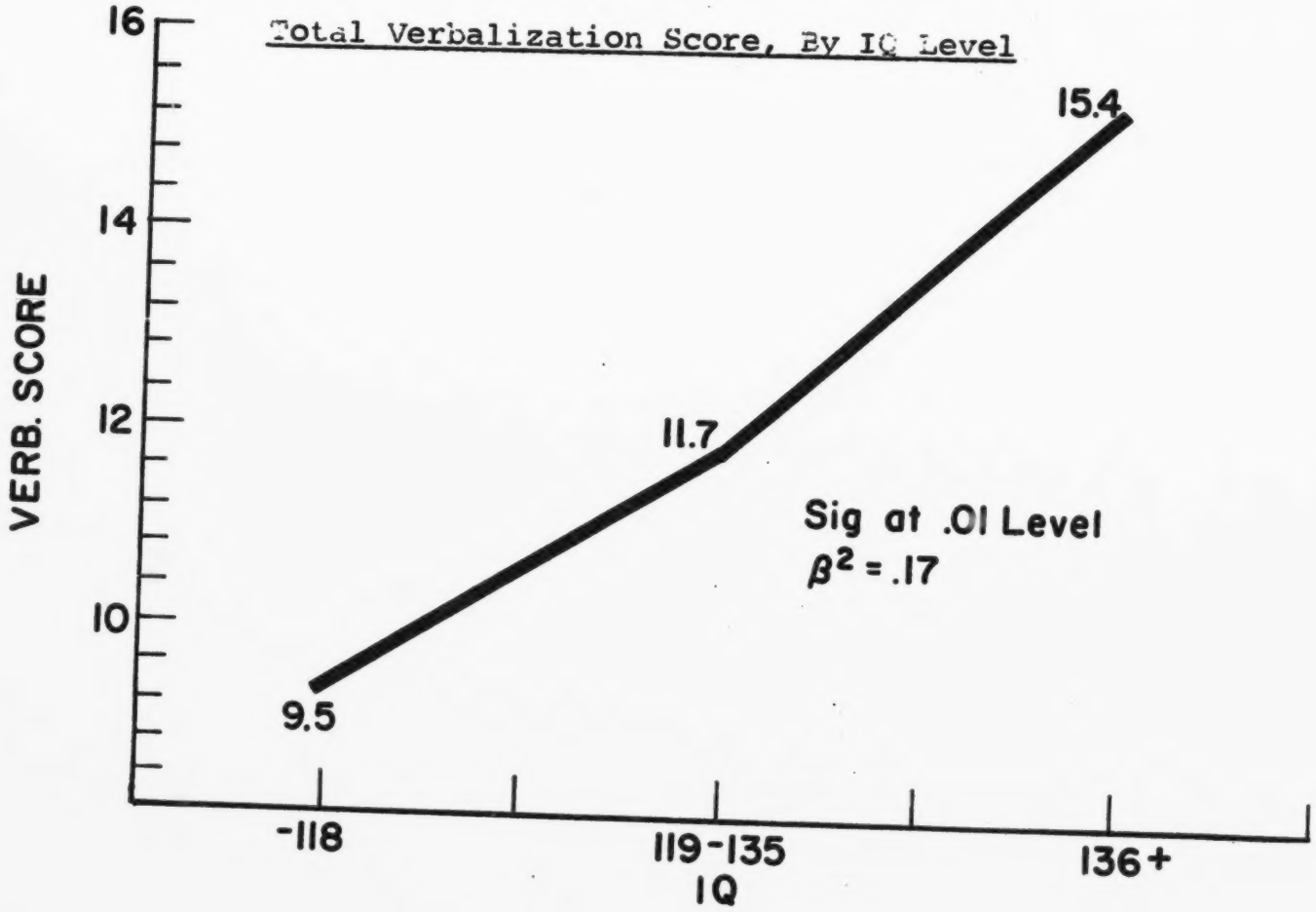


FIGURE 6

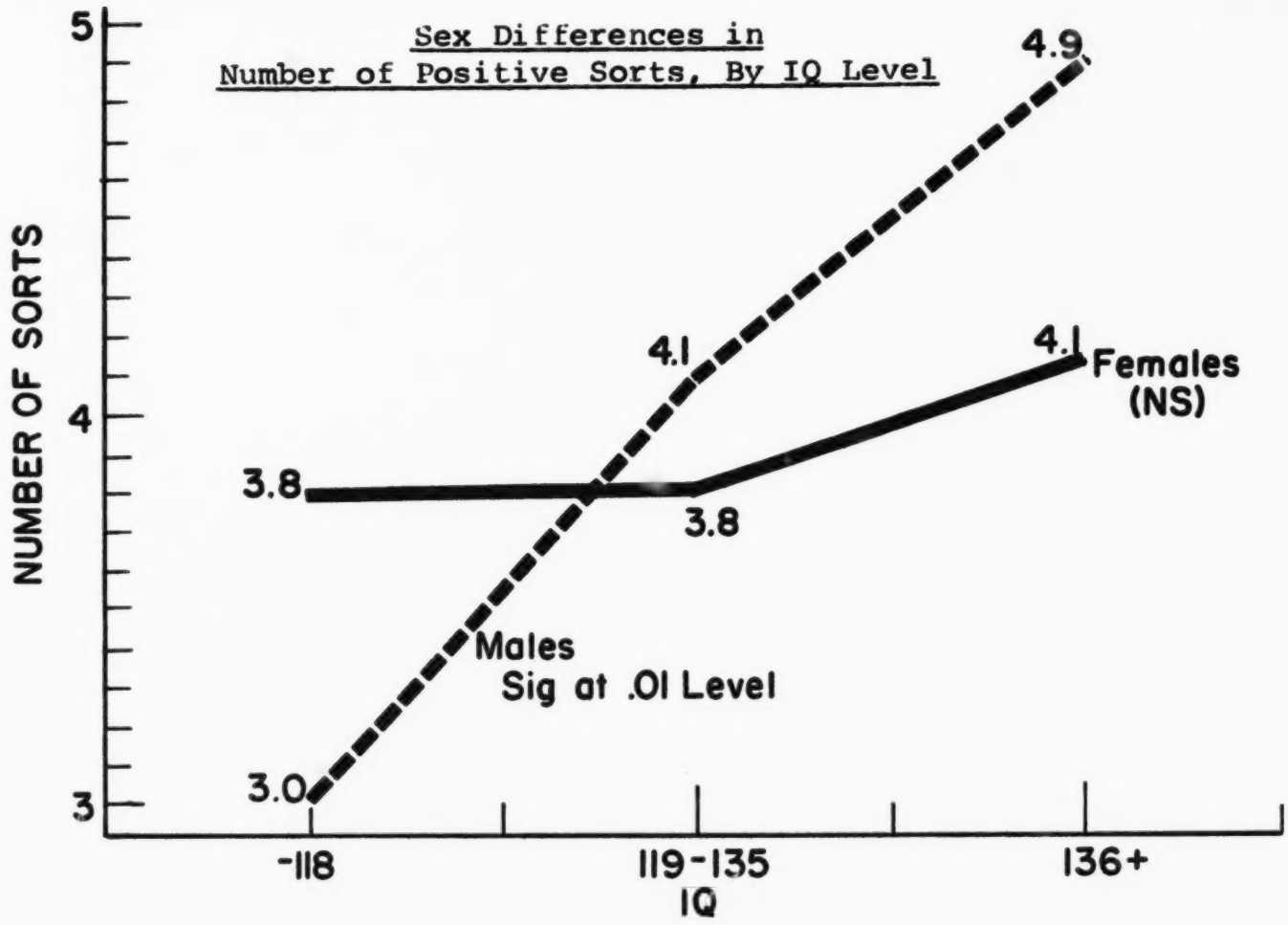


FIGURE 5

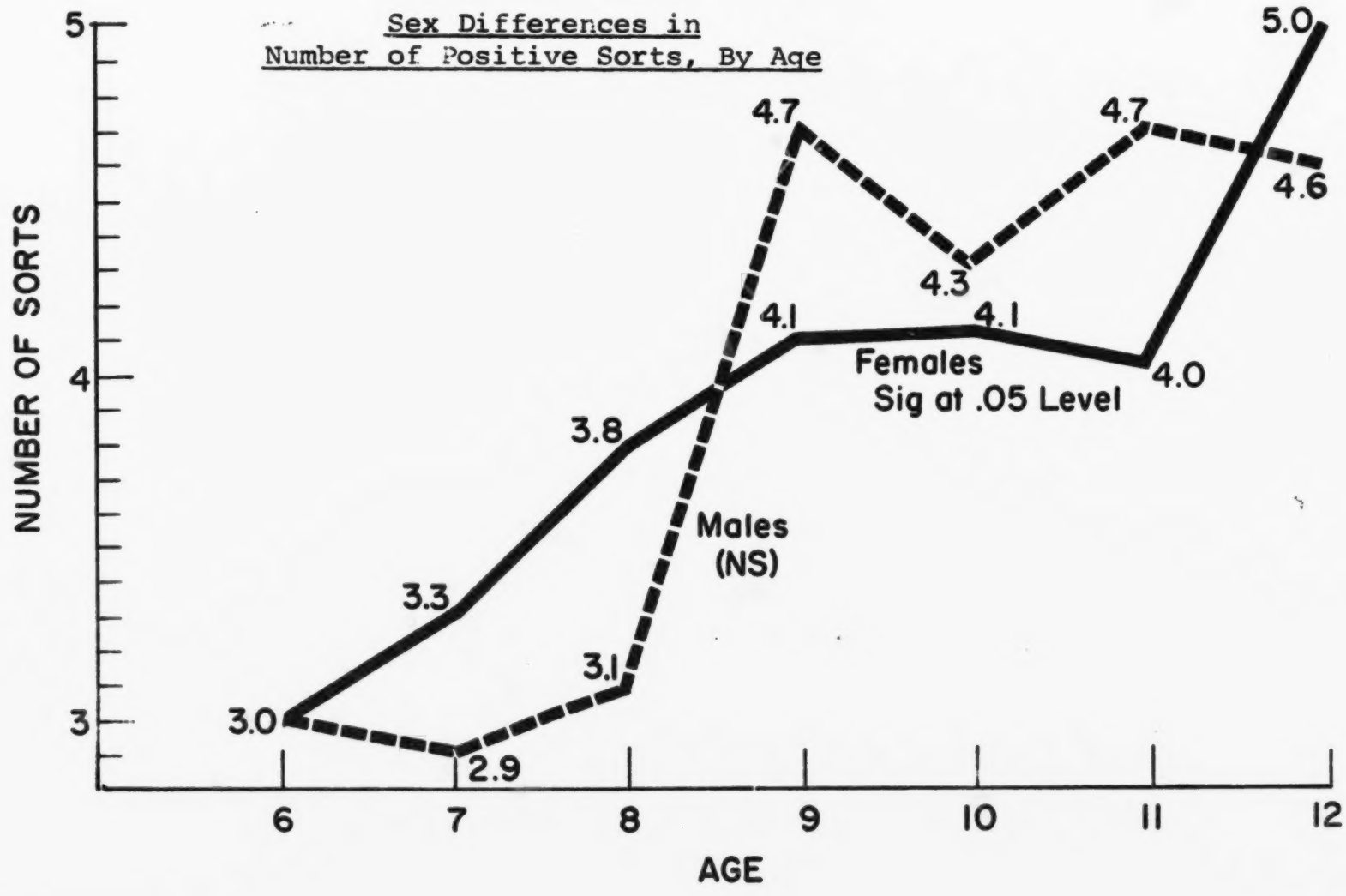


FIGURE 7

Sex Differences in
Mean Verbalization Score, By Age

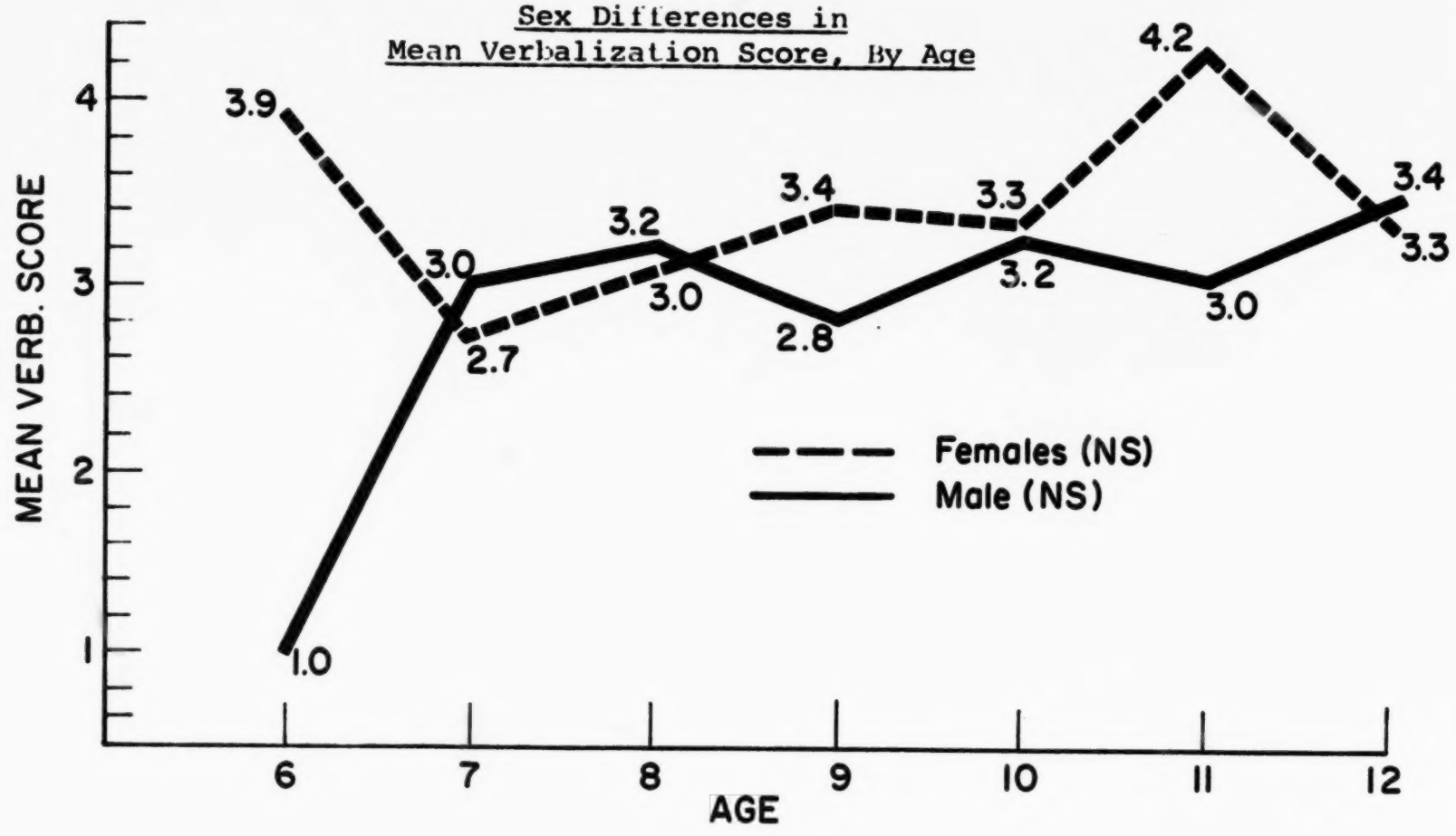
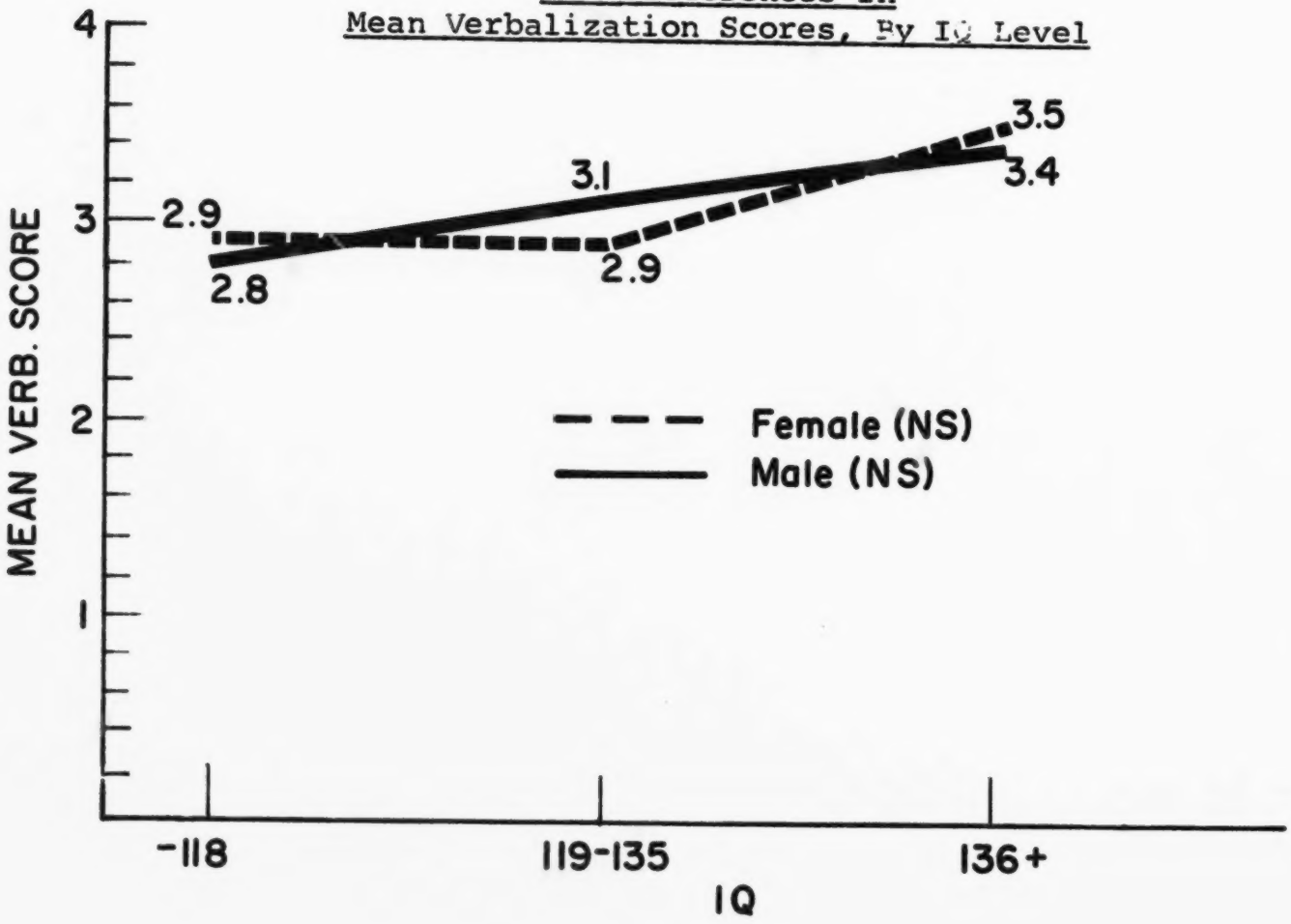


FIGURE 8

Sex Differences in
Mean Verbalization Scores, By IQ Level



APPENDIX C

SUPPLEMENTARY PROCEDURAL INSTRUCTIONS

If a S differentiated between the blocks on the basis of any functional, affective, or physical attribute, he was allowed to continue.

If a S indicated he wanted to change the position of some block(s) and/or wanted to change classification concepts E said, "Do you want me to move some of the blocks?" If necessary, E added, "Which ones?" If a S indicated he wanted to change classification schemes, E, after giving the S the chance to have the blocks moved, said, "Now, how are these blocks different from these?" Additional presentations were made on the basis of the response.

If a S attempted to touch the blocks E told him, "Just point to where the blocks should go."

There were two types of incorrect sorts -- number (evidenced by more than three blocks in a circle) and grouping (evidenced by the blocks in one circle not having the subject-named attribute in common). If the S gave evidence of a number error, E told him, "You should put only three blocks in each circle. You have four blocks in this circle." If the S gave evidence of a grouping error, he was allowed to continue and E made no comment.

If the S in the SPG made no response for one minute he was asked, "Would you like to try two different blocks?" If the S said "No", E waited one minute and if there was still

no response, E ended the test. If the S said "Yes", the next two blocks were presented. If the S in the MPG made no response for two minutes, E ended the test. If a S in either group asked to end the test, E said, "Let's try a few more." If the S repeated the request the test was ended. The test was ended on the first request if the S had made no response for one minute or more.